Outline for SCAR 2 Intro

1. Environmental effects on male and female reproductive traits (in contrast to genetic effects) are important because they can influence reproductive success and ultimately relative fitness
   1. Reproductive traits are uniquely tied to fitness because of the direct effects on offspring produced and genes transferred to next generation – relative fitness (citations)
   2. Female reproductive success is broadly affected by growing conditions
      1. Environmental effects are well documented
         1. Nutrients
         2. Moisture
   3. So is male reproductive success (citations)
   4. Environmental effects on reproductive traits should have consequences for relative fitness (Lau, Ruane, Travers) and evolution
      1. # seeds produced or sired varies with environment
      2. Variance that can obscure genetic differences
      3. Or reinforces them if there is G X E
2. Climate change has increased the relevance of understanding growth environment temperature (environmental effects) on male and female reproductive traits
   1. Climate change
      1. What is happening
      2. Plants will be growing in a warmer world
   2. Consequences
      1. If there are environmental effects on RS, then adaptation to climate change is not simply a matter of better genes winning – the response to selection may be muted or G X E may be more important
      2. We need to know more about what is the effect of growth environment temperature on male and female reproductive traits?
   3. We do not know enough about how environment affects things like reproductive phenotype including secondary sexual characters (flower size, display, attractiveness to pollinators), primary sexual characters (number and quality of pollen and ovules) and direct measures of reproductive success (viable fruit and seed production).
   4. This is the broad goal of our study
3. What do we know about environmental effects on male and female RS?
   1. Non-heat environment
      1. Summarize nutrients and water (specific results - citations)
   2. Heat environment (review things like heat affects on fruit and gametophytes)
   3. What is missing?
      1. Wild plant examples with evolutionary considerations in natural conditions and natural levels of genetic diversity?
      2. Any consideration of heat effects on traits other than fruit or pollen production (i.e. what about pre versus post pollination components of reproductive success)?
      3. Careful dissection of male versus female reproductive success – selection can act on each separately?
      4. Incorporation of geographic variation and local adaptation into experimental design (ala Klaus, Keck and Heisey)
4. We want to understand environmental effects on reproductive phenotype (phenotypic plasticity) and potential G X E patterns of reproductive traits in response to heat in order to understand and predict evolution in a warmer environment.
   1. Our broad goals are:
      1. To measure key reproductive traits in a weedy herb exposed to different temperatures during flower and fruit development as a means of quantifying phenotypic plasticity in these traits
      2. To test for local adaptation and differences in response to environmental conditions between divergent populations from warmer and cooler regions using a common garden approach
      3. To distinguish between environmental effects on traits associated with male and female reproductive success separately
   2. Predictions
      1. In this study, we investigated the effect of long-term high temperatures on reproductive traits in *Solanum carolinense*. We included both pre-pollination (developmental) traits and post-pollination traits to understand how heat may influence phenotype throughout the process of sexual reproduction. If *Solanum carolinense* responds to long-term heat stress as does tomato, then we predict significant negative effects on floral morphology, male and female viability, and fruit and seed set. However, because southern populations are in warmer environments we also predict negative responses to heat will be reduced relative to northern populations.
   3. Our specific objectives to assess these patterns were:
      1. Grow plants from northern (Minnesota) and southern (Texas) regions in a common garden setting to remove environmental variation between divergent genotypes
      2. Experimentally test the effects of hot (32C) temperatures versus control (25C) temperatures during flower and fruit development on phenotypic expression of pre and post pollination reproductive traits
      3. Compare the responses of plants from different regions to heat treatments to measure potential GXE effects and the potential for environmental effects to reduce the response to selection.

Outline of Discussion

1. Are there environmental effects on plant reproductive characters?
   1. Heat influences some characters but not all
   2. Implications
      1. Relative fitness partially a function of environment and not just genotype – this should reduce response to selection by unlinking genotype and phenotype
      2. In particular, there was phenotypic plasticity in pollen diameter and viable seeds per fruit
         1. Pollen diameter implications – if size is related to competitive ability then siring success may be linked; discuss implications of ROS idea
         2. Seed viability – clear decrease in fitness with environmental effect; implication that warmer populations or individuals will have lower fitness regardless of genotype
2. Are there differences between north versus south in response to heat that are suggestive of G X E interactions?
   1. Some traits responded to heat differently if plants originated in different populations suggesting G X E patterns
   2. In the north, heat caused an increase in propensity to flower and a decrease in proportion staminate flowers but the opposite trends in the south
   3. Implications
      1. Suggestive that heat is a stress signal in the south; plants respond by decreasing reproductive effort and investment in female reproductive success
      2. These may be examples of adaptive phenotypic plasticity and suggest a shift away from sexual reproduction with warming temperatures
3. Are there initial differences in reproductive traits between north and south that suggest local adaptation
   1. Flower morphology is bigger (fruit size too, anectdotally) in the south
   2. Why? Protect ovules and seeds?
4. Conclusions